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A. V. Tchesunov

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A New Free-Living Arctic Sea Ice Nematode

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UDC 595.132 *Theristus* sp. n.

A NEW FREE-LIVING ARCTIC SEA ICE NEMATODE

by

A.V. Chesunov

An illustrated description of *Theristus melnikovi* sp. n., which is similar to *T. acer* in the structure of the copulatory organs and other features, but is different from the latter in having a much longer and thinner body. The new species occurs in very large numbers in the intercrystalline capillary spaces of the lower part of drifting sea ice in the Central Arctic basin. The summer, with its more favourable salinity levels and temperatures, appears to be the time when *T. melnikovi* sp. n. actively feeds and reproduces. For most part, only the larvae survive the winter, due to the fact that they do not feed actively or do not feed at all.

Some publications on the biology of the Arctic sea ice mention nematodes among the animals inhabiting the inner spaces and the lower surfaces of ice floes; in some papers the nematodes are even described as constituting the most numerous group in the zoocenosis (Horner, 1976; Mel'nikov, 1980; Mel'nikov, Kulikov, 1980; Grainger et al., 1985). Until recently, however, very little information was available on the taxonomic composition of these nematode populations, nor was it clear whether they lived in this highly unusual biotope as its permanent, specific or casual inhabitants. Nothing was known about what they fed on, how they were distributed in the ice, when they reproduced and how long their life cycle was. The present paper will deal mainly with the first of these questions.

The nematodes studied by this writer were collected by I.A. Mel'nikov (Institute of Oceanology of the Academy of Sciences of the USSR) at the drifting station "North Pole-22" in 1980-1981. Cores, 18 cm in diameter, were obtained from the ice and then cut into segments 30 cm long. Indoors, at room temperature, the ice melted, and its inhabitants were fixed in 4% formaldehyde. Then, using Seinhorst's method, the nematodes were transferred to glycerin and placed in permanent glycerin mounts sealed with glycyl. The cores were found to contain representatives of three free-living nematode species of the family Xyalidae (order Monhysterida). Two of the species were represented by just a few specimens, whose condition made it

impossible to describe them. The third - the most abundant - species is described below.

Theristus melnikovi Tchesunov, sp. n.
(Fig. 1)

Material. Holotype ♂, catalogue No. JC-230. Paratypes - 3♂♂, 3♀♀. Arctic Ocean, drifting station "North Pole-22", April 12, 1981, 85°08′ N, 156°54′ E, old ice 320 cm thick, 290-320 cm layer; deposited with the Zoological Museum of Moscow University.

Description. Body very long and thin, almost cylindrical. Males: body length 2060-3440 µm, a = 68.6-79.8, b = 5.68-7.52, c = 12.4-16.1. Females: body length 2940-3565 µm, a = 65.4-72.7, b = 5.64-6.56, c = 11.6-13.7, V = 70.2-72.0%. In males, the diameter of the body is 20.6-23.2 µm at the level of the cephalic setae, 36.3 µm at the nerve ring, 28.0-40.4 µm at the cardia, 28.0-46.7 µm in the middle, 29.7-37.3 µm at the anus. In females, the body diameter at the same levels is 23.1-24.8 µm, 39.6 µm, 34.6-44.5 µm, 40.5-54.5 µm, 23.1-24.8 µm, respectively. The cuticle is annulated, the annulation being particularly pronounced near the anterior end. Lateral fields are not expressed.

The six membranous lips which cover the mouth opening form a low-conical lip region. At the base of each lip there is a small labial seta. Farther back, there is a ring of 12 cephalic setae (6 pairs). In the latero-median pairs, the shorter seta occupies a more lateral position; in the lateral pairs, the shorter seta occupies a more ventral position than the long one. The (longest) cephalic setae are 14.8-15.7 µm long in males and 14.8-18.2 µm long in females. The long setae are approximately 1.2-1.5 µm times as long as the short ones. Farther back, the body bears very infrequent and short (up to 6 µm) somatic setae. The amphid, small, slightly transversely oval, is located below the level of the end of the stoma. From the centre of the amphid, a nerve extends interiorly and posteriorly, widening rapidly to become fusiform. In males, the amphid is 8.2-8.3 µm wide, which accounts for 35-38% of the body diameter at the corresponding level; the distance between the anterior end of the body and the amphid is 30.5-37.2 µm. In females, the respective quantities are 7.4-8.3 µm; 24-29%; 34.7-40.5 µm.

The lips are membranous with very small inner folds. The stoma appears to consist of two cones joined at the base, whose anterior portion (frustum) is bigger than the posterior portion. The walls of the stoma are slightly sclerotized, growing thinner and more flexible on either side of the boundary between the two portions. The cuticle of the cephalic end seems to split twice at the approach to the stoma, this being indicated by two very

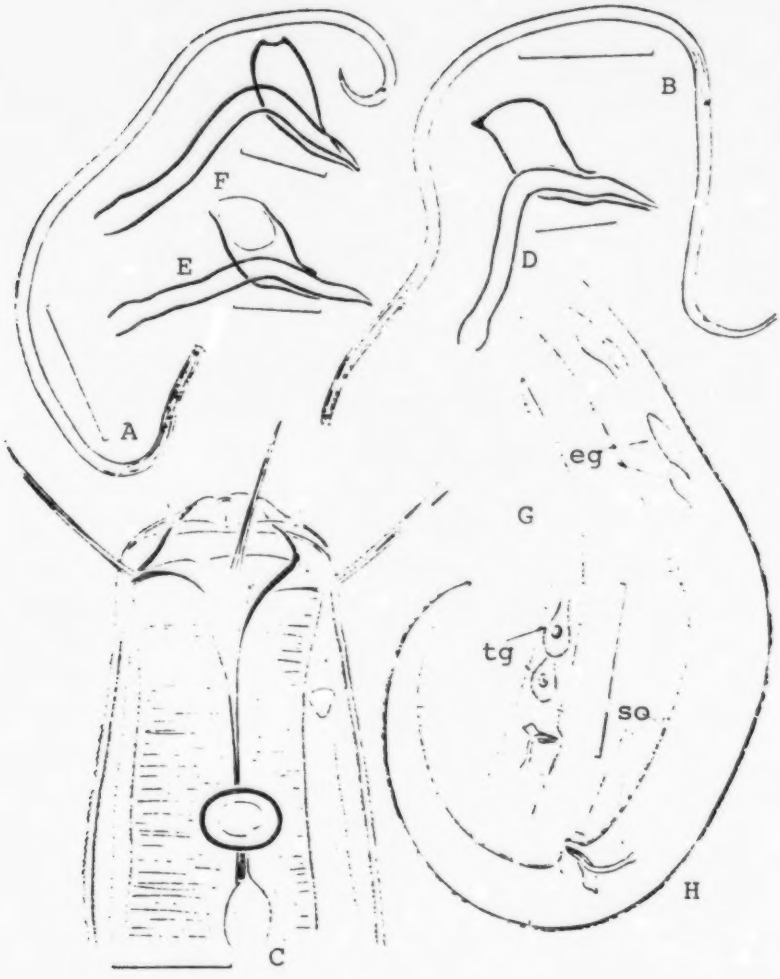

Fig. 1. *Theristus melnikovi* sp. n.: A, B - general view; C - head; D-F - copulatory organs; G, H - tail and posterior part of the body; A, C-F - ♂♂; B - ♀; *so*- supplementary organs, *tg*- tail glands, eg - ejaculatory glands. Scale (μm): A, B - 500; C, E, F - 10; D, G, H - 100

thin stomatoidal rings in the anterior portion. The boundary of the esophageal collar lies in the region of contact between the anterior and posterior portions of the stoma - this place is marked by a thin esophageal ring with weakly expressed esophageal seams. It is possible that the body cuticle is in some kind of contact with the stoma near the boundary of the esophageal collar, which, however, is not clearly evident. In some of the specimens, two granules are discernible in front of the amphids on the dorsal side of the esophagus - possibly, discoloured ocelli, resembling those of *Penzancia bipunctata*. The esophagus widens very slightly and evenly towards the cardia. The cardia is oblong, slightly elongated.

The female genital tube is to the left of the intestine. The uterus is elongated, with no post-vulvar sac. Vulval glands are present anterior and posterior to the vagina. The anterior testis is to the left of the intestine, almost reaching the cardia. The posterior testis is to the right of the intestine. At the level of the posterior part of the sperm duct lie the small elongated ejaculatory glands. Altogether, there are four of those, grouped in pairs, one following the other. The ducts of the ejaculatory glands cannot be discerned. Anterior to the male cloaca, there are four or five very small ventral supplements in the form of thin tubules in the cuticle. Some of the tubules exude a secretion. The spicules are small, with a knee-like bend in the middle, bidentate distal ends and weak proximal knobs. The gubernaculum has a ventral groove, a thin sheath enveloping the distal part of the spicule, and an irregularly rectangular dorsocaudal apophysis. The length (span) of the spicule is 28.0-31.3 µm; the length of the apophysis is 9.9-13.0 µm.

The tail is elongated, conical, with no thickening at the end. In males, the tail is 5.76-6.25 times as long as the diameter of the anus. In females, it is 8.04-9.20 times as long. Discernible inside the tail are two round caudal glands, whose ducts are not visible. In males, the tail bears a row of 8-9 subventral setae 5-8 µm long.

Differential diagnosis. Based on the structure of the copulatory organs, *T. melnikovi* sp. n. must be assigned to the *T. acer* group of species, while some of its other features make it appear particularly similar to the main species of this group: *T. acer* Bastian, 1965. However, the new species differs quite distinctly from *T. acer* in having a long, filiform body (according to many descriptions, the body of *T. acer* is 1-2 mm long, and its index "a" is 21-43). *T. acer* is widespread along the sea coasts in the temperate and cold zones of the Northern Hemisphere, where it normally inhabits littoral silted sand but also occurs in areas of marine overgrowth. Like *T. acer*, *T. melnikovi* sp. n. is characterized by considerable variability.

In some of its body measurements *T. melnikovi* sp. n. also resembles two other species from the *T. acer* group: *T. gracilis* (de Man, 1876) and *T.*

leptosoma Allgen, 1940 (the descriptions of these species are, unfortunately, very brief), but surpasses them considerably in body length.

Biotope and mode of life. *T. melnikovi* sp. n. inhabits old polar sea ice (Zakharov, 1981; Mel'nikov, 1980, 1984). The ice is 3-5 m thick, its thickness varying from the highest values in the central part of the Arctic Ocean to the lowest values in the peripheral regions of the basin. It is now known that sea ice consists of parallelly arranged crystals and that the spaces between the crystals are filled with a liquid, viz. brine. The shape and size of the intercrystal spaces vary widely, changing as a function of the distance from the water-ice interface. The spaces in the bottom layers are mostly in the form of capillaries and so-called brine flow channels. They all run parallel to the vertically arranged crystals. It is these spaces, filled with brine and communicating with the sea, that serve as a habitat for *T. melnikovi* and some other small organisms. Apparently, the network of narrow passages (with a diameter of 50-100 μm and up) among the ice crystals is in some measure similar to the capillary interstices among the sand particles on the bottom of the sea, which is the normal and principal biotope of the free-living marine nematodes.

The salinity of the liquid in which the nematodes live is not constant: in summer, it is similar to that of the sea water, amounting to about 30‰; in winter, when the temperature of the ice goes down and the process of ice formation begins inside the ice mass, the brine across the entire section of the ice floe becomes more concentrated, reaching 100‰ and over. The temperature of the ice at the lower surface is fairly constant throughout the year: (-1.4°C)-(1.8°C), and is roughly equal to the temperature of the sea water in contact with the ice; the temperature of the upper layer of the ice varies from 0°C in summer to (-20°C)-(-30°C) in winter.

We studied five ice cores obtained at the SP-22 station in February-April, 1980-1981. In each of the cores nematodes were found only in the lowermost metre of the ice (Fig. 2). What surprised us, however, was the fact that they were most abundant not in the bottom layer of the ice, where the conditions seemed to be particularly favourable, but at a level of 30-60 cm up from the water-ice interface.

Nematodes form the basis of the cryointerstitial fauna complex identified by I.A. Mel'nikov (personal communication). Like the other cryointerstitial forms (infusorians, amoebas, heliozoans, turbellarians, copepods, amphipods), the nematodes seem to feed on the rich cryointerstitial diatomaceous flora, which vegetates mostly during the summer months, and on bacteria. However, we found no diatom shells in the intestines of the specimens we examined, although it is known that nematodes with the *Theristus*-IB type of stoma, according to Wieser's classification (Wieser, 1959), do not pump out the contents of diatom shells after opening or piercing them, but swallow them whole. The intestines of

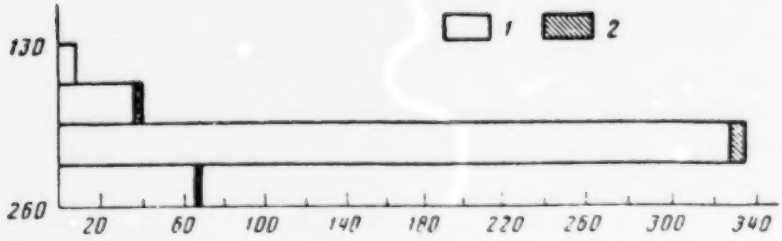

Fig. 2. Vertical distribution of *Theristus melnikovi* sp. n. in the ice at 85°06′ N, 157°59′ E on April 8, 1981 (the most complete series of vertical core samples available): X-axis - the number of nematodes in a vertical column segment 18 cm in diameter; Y-axis - ice thickness, cm; *1*- larvae, *2*- adults

the nematodes from the cores we studied did not contain anything at all, which is probably due to the fact that the nematodes do not feed during the winter months when the cores were obtained. It should be noted that during this period the nematodes are not in a state of profound cryptobiosis or, at least, can come out of this state very fast. I.A. Mel'nikov reports that the nematodes from the melted ice cores he examined appeared to be highly motile.

The ability to survive sub-zero temperatures is characteristic also of the littoral nematodes living in the temperate climatic zone. Experiments in which samples of soil containing live meiobenthos were frozen through (Farke et al., 1984) showed that free-living nematodes from the coasts of the North Sea were able to survive for one or two days temperatures as low as -5°, -10° and even -20°C. These experiments also showed the euryhaline species to be particularly resistant to very intense and prolonged cold, because the ability to survive freezing is related to the ability to withstand osmotic stress. *T. melnikovi* appears to have an extraordinary capacity for surviving long periods of low temperatures in a hyperhaline solution. It is interesting to note in this connection that *T. acer*, which is particularly closely related to *T. melnikovi*, is also a euryhaline species capable of withstanding wide fluctuations in the levels of salinity (cf. Heip et al., 1985).

Worth noting is the very low proportion of mature adults in each of the core samples (Fig. 2). None of the few females found in the cores carried any eggs that were ready for deposition. The number of males in the core samples was slightly higher, but many of them, having apparently been fixed when already dead, were partially macerated. *T. melnikovi* seems to have a long life cycle with seasonal reproduction. Laboratory studies have shown that at low temperatures the life cycle of littoral nematodes may extend for many extra months (Gerlach, Schrage, 1971). It is possible that *T.*

melnokovi feeds, grows and reproduces with particular vigour during the summer light period, when the salinity levels are more favourable, the temperature is slightly higher, and the ice flora vegetates and reproduces at an icreased rate.

In the winter months, the nematodes, most of them at the different larval stages, practically stop feeding. During the cold period, the ice grows thicker, due to crystallization at the lower surface. As a result, the flora and fauna of that surface become embedded in the ice. In summer, the upper surface of the ice floe melts a little, and the resulting water flows down through the cracks and channels in the ice. In this way, as the seasons change, the population of the ice floe gradually moves into higher layers, where salinity and temperature conditions are less favourable. Marine diatom cells stop reproducing and degenerate in the upper layers of the ice. In the end, their shells with the remains of organic matter are brought to the surface. It seems likely that the nematodes rise to the surface in the same passive manner, which would explain the shift in their abundance upwards from the lower surface of the ice during the winter months. In the course of the year, the ice floe grows thicker from below by approximately one meter, and that is roughly the level at which the nematodes were found. Nematodes, however, have greater locomotion capacities than diatoms. It is possible that during the summer, after the winter diapause, they can actively change their position inside the ice mass and move down into the lower layer again.

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Moscow University,
Department of Biology

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